STRUCTURE OF WOOD IN BLUEBERRY AND HUCKLEBERRY[1]

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(WITH PLATES X, XI)

According to EAMES,[2] the anatomy of the northern oaks is characterized by small uniseriate rays, and large ones which are many cells in width and generally fusiform in shape. It has been shown in this article that the large rays have developed from the aggregation of small ones through the transformation of fibers into parenchyma. As evidence he figures the wood of *Quercus*, especially seedlings, to elucidate the broad ray in the process of formation by fusion of small rays, and the gradual transformation of the separating fibers into parenchymatous elements. A study of the material investigated by EAMES justifies his conclusion. As a preliminary to the present investigation, some illustrations of the anatomy of a seedling oak have been introduced. Fig. 1 shows in tangential view a portion of the wood of the epicotyl of *Quercus velutina* with two characteristic kinds of rays. The broad ray in the central part is plainly in the process of formation, the parenchyma cells being interspersed with fibers in all stages of division and transformation into parenchyma. Fig. 2 is a transverse view of the situation in fig. 1. The broad ray here shows two kinds of cells, the dark parenchymatous ones, and the lighter ones which represent more or less modified fibers. Fig. 3 shows a view in the same plane as fig. 1, but more highly magnified. The manner in which the ray becomes solidly parenchymatous is even more apparent here, especially at the left of the figure, where we see a fiber partially divided into parenchyma cells.

With this preliminary reference to the anatomy of *Quercus*, it is possible to pass advantageously to the consideration of the anatomy of *Vaccinium* and allied genera, which show interesting and strik-

[1] Contribution from the Laboratory of Plant Morphology of Harvard University.

[2] EAMES, A. J., On the origin of the broad ray in *Quercus*. BOT. GAZ. **49**:161–167. *pls. 8, 9.* 1910.

ing points of similarity with the conditions already mentioned. *V. corymbosum*, as shown in transverse view by fig. 4, is seen to have broad and also uniseriate rays, as does *Quercus*. Although the large rays are not so broad as the corresponding rays of the oak, yet they are similar to the latter in the strong contrast which they present to the small uniseriate ones. The large ray of *V. corymbosum* (fig. 4) is composed of two kinds of cells: light, rather larger ones; and dark, smaller ones (the ordinary parenchymatous ray cells), a condition which exactly parallels the organization of the ray of the oak just noted. Fig. 5 shows a portion of this same transverse view of the wood of the stem of *V. corymbosum* more highly magnified, so that the twofold composition of the ray becomes even more apparent. Fig. 6 is a tangential aspect of the wood of the stem of *V. corymbosum* corresponding to fig. 4. In this plane also the two kinds of rays, uniseriate and broad, are likewise visible. The presence of two kinds of cells in the large ray, one dark and rather small, the other light and somewhat larger, can also be distinguished clearly. Obviously the large ray is a compound structure, just as has been proved in the case of the corresponding large rays of the oak, with which the large ray of *V. corymbosum* appears to be identical in so far as it is composed of the two kinds of cells described.

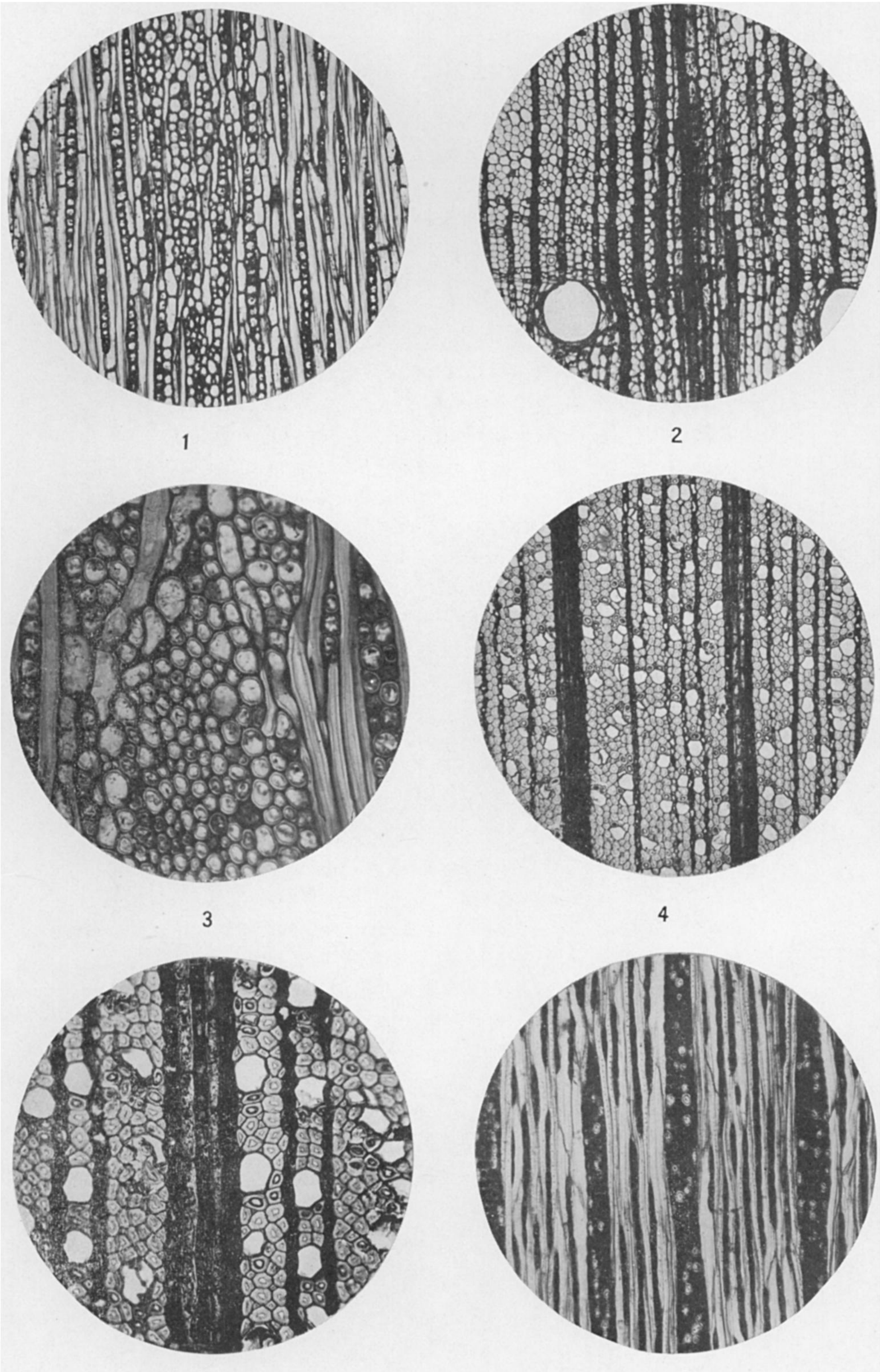
Vaccinium pennsylvanicum shows the same situation as *V. corymbosum*, as is vouched for by figs. 7 and 8. In fig. 7 the contrast between broad and narrow rays is readily distinguished. The large number of light colored cells present in the broad ray plainly shows indication of origin from the transformation of fibrous elements into parenchyma. An enlarged view of this situation is given in fig. 8, which represents a higher magnification. The light cells are strikingly different from the ordinary ray cells which they accompany, and the seriate ones in the central portion are obviously derived from a transformed fiber. The whole structure is consequently a compound ray resembling that found in the wood of the oak. In fig. 9 the same condition is noted as in fig. 7, namely, rays of two sharply contrasting types, broad and uniseriate. Of these the large ones are compound in structure, showing derivation by the fusion of small rays as well as by the transformation

of fibers into parenchyma cells. This figure represents in tangential view the wood of the root of *Gaylussacia*, a genus closely allied to *Vaccinium* and having identical ray structure, as is seen by the comparison of the two woods illustrated in figs. 7 and 9.

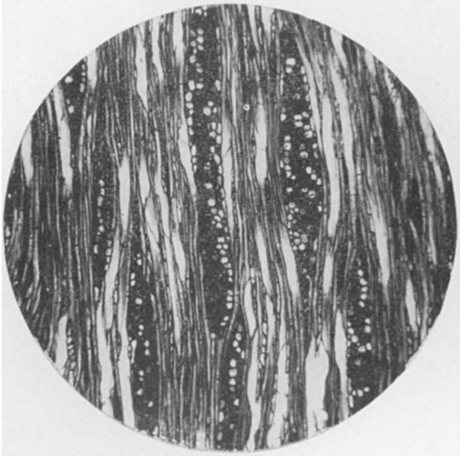
Fig. 10 is a tangential view of the wood of the root of *Rhododendron*, a genus also allied to *Vaccinium* although not so closely as is *Gaylussacia*. The wood as shown here is much like that of the northern oaks, especially in the marked contrast between its large and small rays. The construction of the ray itself in *Rhododendron*, however, is more clearly seen in fig. 11, a transverse section of the same wood. The interspersion of the light colored fibrous elements through the ray at once shows its composite character, and although it does not illustrate actual transformation of fibers into radial parenchyma, it points the way to that as a natural solution of the origin of the broad ray in this genus.

In regard to *Vaccinium* and the allied *Gaylussacia* it is now clear that the large rays in these genera are of the same nature as those of *Quercus*, and like them are in strong contrast to the more numerous uniseriate rays. In *Rhododendron* also we noted the same condition, albeit its origin was not in all respects so clear. That this condition of *Vaccinium* and allied genera, which is so similar to that found in the oak, is not common to all ericaceous woody types, is evidenced by fig. 12, which shows in tangential view the wood of the stem of a species of *Arbutus*. The rays of this wood do not fall into two strongly contrasting categories, the broad and the uniseriate. Rather do they grade into each other and are only relatively broad or narrow when compared with each other. In this respect *Arbutus* presents the general situation for forest trees, the majority of which do not possess contrasted broad rays and uniseriate rays, but have all their rays comparatively small and of intergrading dimensions.

From this examination of the genus *Vaccinium* and other genera allied to it, and the comparison of them with the wood of *Quercus*, we must conclude that the well known large rays of the latter have their counterparts in the somewhat smaller rays of *Vaccinium* and *Gaylussacia*. These rays, although of considerably smaller dimensions, are in just as marked contrast to the accompanying



FLINT on VACCINIUM



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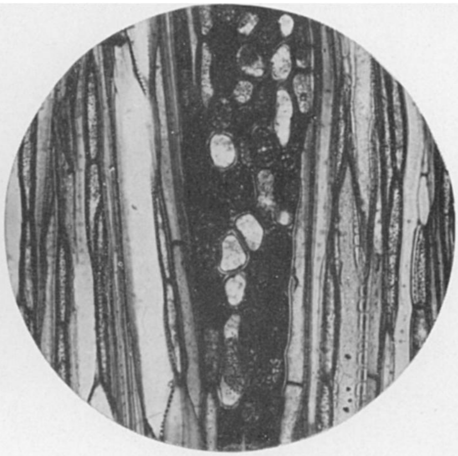

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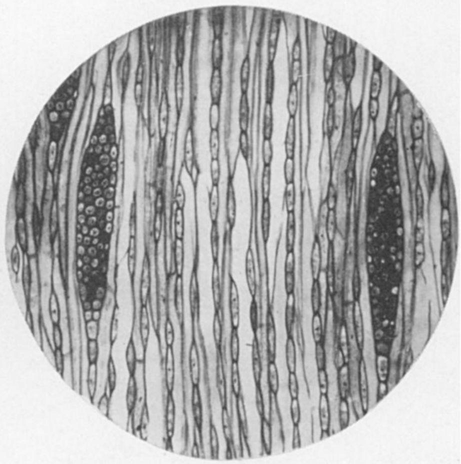

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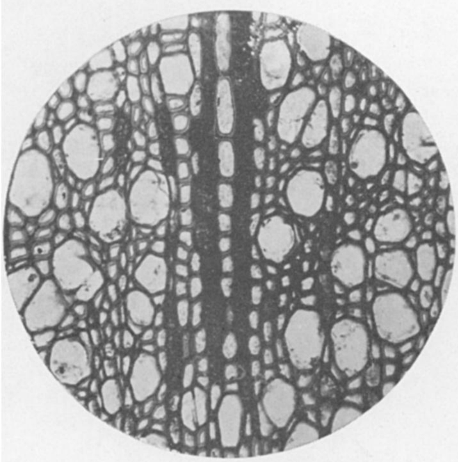

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FLINT on VACCINIUM

uniseriate rays as are the broad rays in *Quercus*. Because of this sharp contrast, and because of the similar origin of the broad rays, they are obviously the exact counterparts of the broad parenchymatous bands in the secondary wood of *Quercus*.

In conclusion, I wish to thank Dr. E. C. JEFFREY of this laboratory for material and advice rendered during the course of this investigation.

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EXPLANATION OF PLATES X, XI

FIG. 1.—Longitudinal tangential section, aggregate ray of seedling of *Quercus velutina;* $\times 100$.

FIG. 2.—Transverse section, wood of seedling of *Q. velutina;* $\times 100$.

FIG. 3.—Longitudinal tangential section, wood of *Q. velutina;* $\times 200$.

FIG. 4.—Transverse section, wood of stem of *Vaccinium corymbosum;* $\times 100$.

FIG. 5.—Transverse section, wood of stem of *V. corymbosum;* $\times 200$.

FIG. 6.—Longitudinal tangential section, wood of stem of *V. corymbosum;* $\times 100$.

FIG. 7.—Longitudinal tangential section, wood of subterranean stem of *V. pennsylvanicum;* $\times 100$.

FIG. 8.—Longitudinal tangential section, wood of root of *V. pennsylvanicum;* $\times 200$.

FIG. 9.—Longitudinal tangential section, wood of root of *Gaylussacia* species; $\times 100$.

FIG. 10.—Longitudinal tangential section, wood of root of *Rhododendron* species; $\times 100$.

FIG. 11.—Transverse section, wood of root of *Rhododendron* species; $\times 200$.

FIG. 12.—Longitudinal tangential section, wood of stem of *Arbutus* species; $\times 100$.